The revolving plate is kept in motion by clockwork, which is set in motion by an electric seismoscope. (See No. 8.)

2. *Seismograph writing on a drum.*—In this instrument the record is written on a band of paper, the diagram being less difficult to interpret because it is written to the right and left of a straight line and not round a circle.

3. *Seismograph writing on a band of paper.*—In this instrument not only is the diagram written along a straight line but it is written with pencil,—the trouble of handling smoked paper being therefore avoided. When the earthquake ceases, the drum ceases to revolve, but if a second or third earthquake should occur, it is again set in motion. By this means a series of earthquakes may be recorded, the resetting of the instrument being automatic.

4. *Seismograph without multiplying levers.*—This instrument is intended to record large motions, the horizontal levers not being prolonged beyond the steady points to multiply the motion. For large earthquakes, when the ground is thrown into wave-like undulations, special instruments which measure tilting are employed.

5. *Duplex pendulum seismograph.*—In this case a steady point is obtained by controlling the motion of an ordinary pendulum with an inverted pendulum. The record consists of a series of superimposed curves written on a smoked glass plate.

6. *Mantelpiece seismometer.*—This is intended for the use of those who simply wish to know the direction and extent of motion as recorded at their own house. It is a form of duplex pendulum, and it gives absolute measurements for small displacements.

7. *Tromometer.*—This is one form of an instrument which is used to record movements which are common to all countries, called earth tremors. Every five minutes, by clockwork contacts and an induction coil, sparks are discharged from the end of the long pointer to perforate the bands of paper which are slowly moving across the brass table. If the pointer is at rest, then a series of holes are made following each other in a straight line, but if it is moving, the bands of paper are perforated in all directions round what would be the normal line of perforations.

The earth movements which cause these disturbances are apparently long surface undulations of the earth's crust, in form not unlike the swell upon the ocean.

A more satisfactory method of recording these motions, which has been used for the last two years, is by a continuous photograph of a ray of light reflected from a small mirror attached to a small but extremely light horizontal pendulum.

8. *Electrical contact maker.*—These instruments are delicate seismoscopes, which on the slightest disturbance close an electric circuit, which, actuating electric magnets, set free the machinery driving the recording surfaces on which diagrams are written.

9. *Clock.*—At the time of an earthquake the dial of this clock moves quickly back and forth and receives on its surface three dots from the inkpads on its fingers. It thus records hours, minutes, and seconds, without being stopped.

10. *Model of an earthquake.*—The bent wires represent the path traced by an earth particle at the time of the earthquake of January 15, 1887. The numbers indicate successive seconds. This model was made by Prof. S. Sekiya.

11. *Safety lamps.*—These are lamps which if overturned are at once extinguished. One of these is a European invention and the other Japanese.

12. *Pictures.*—The pictures on the walls show the effects of the Great Earthquake of October 28, 1891, the devastation following the Eruption of Bandaisan in 1887, and several of the more important volcanoes in Japan. They were made by Prof. W. K. Burton.

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UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Last Term the Board of Faculty of Natural Science recommended that an honour examination in Natural Science should be instituted, bearing the same relation to the Final School that Moderations bear to the Final School of Literae Humaniores. The recommendation of the Board was not unanimous, and on the matter coming before the Hebdomadal Council last week, it was put aside on the ground of want of unanimity among the various scientific departments. There was much to be said both for and against the proposed examination. It would probably have raised the standard of the chemical and physical work done by biologists, but would have forced an additional subject on the chemists and physicists, which they were very unwilling to assent to.

CAMBRIDGE.—The Adams Prize has been awarded to Prof. J. H. Poynting, F.R.S., late Fellow of Trinity College, for a memoir on the methods of determining the absolute and relative value of gravitation and the mean density of the earth.

The Professor of Pathology (Mr. Roy) gives notice that on Thursday, February 9, a lecture and demonstration will be given by Dr. Hafkine, of the Pasteur Institute, on his method of conferring immunity against Asiatic cholera. The lecture will be delivered at the Pathological Laboratory at 4.30, and will be open to members of the University.

The office of Esquire Bedell has been rendered vacant by the death of Mr. F. C. Wace, a distinguished mathematician, formerly Fellow and Lecturer in Mathematics at St. John's College, and thrice elected Mayor of the Borough of Cambridge.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 1.—Essay towards an extension of Maxwell's Theory, by Hermann Ebert. The author obtains expressions for dispersion and absorption of waves of the order of light-waves analogous to those obtained by Goldhammer, and shows that they may be derived from Maxwell's fundamental conceptions by applying them to the case of rapidly changing displacements.—A new kind of magnetic and electric measuring apparatus, by G. Quincke. These are made of glass, ebonite, and wood. No screws are used in their construction, and they are claimed to cost a tenth of the price of ordinary instruments, with equal accuracy. In each of them the needles are suspended at the hollow centre of a vertical circular glass disc.—On a null method for measuring the dielectric constants of conducting liquids, by Friedrich Heerwagen.—On a phenomenon analogous to Newton's rings observed during the passage of Hertz electric plane waves through plane-parallel metal plates, by Ludwig Boltzmann. The author removes an apparent contradiction between Maxwell's theory and Hertz's observation that even excessively thin metal plates do not transmit electric waves a few decimetres long, by showing that this is not due to absorption, but to the limiting conditions at the surfaces of separation deducible from Maxwell's formulæ.—On a medium whose mechanical properties lead to the equations propounded by Maxwell for electromagnetism, by L. Boltzmann.—On some questions concerning Maxwell's theory of electricity, by L. Boltzmann.—The index of refraction of electric rays in alcohol, by H. O. G. Ellinger.—On the electrification of air in glow and brush discharges, by Ad. Heydweiler.—On the calculation of magneto optic phenomena, by P. Drude.—Spectra of aluminium, indium, and thallium, by H. Kayser and C. Runge.—On the infra-red spectra of the alkalies, by H. Kayser and C. Runge. A criticism of Benjamin Snow's work on the same subject.—Investigations concerning interior conduction of heat, by Richard Wachsmuth.—On the absolute value of the thermal conductivity of air, by A. Winkelmann.—On a modification of the transpiration method suitable for the investigation of very viscous liquids, by C. Brodmann. The substance was made to pass from a funnel-shaped reservoir through a capillary tube into a beaker standing on one pan of a chemical balance. The time was noted at which the amount of liquid passed into the beaker was large enough to overcome the counterpoise in the other pan, and to disturb the equilibrium, and further small weights were added and similarly dealt with. The temperature was kept constant by a spiral water-pipe and felt jacket, and local differences and variations of level and buoyancy were corrected for. The liquid experimented upon was glycerine, and the temperature curves were hyperbolas.—Notes on M. Cantor's thesis on capillary constants, by Th. Lohnstein.—Note on the purification of mercury, by W. Jaeger.

Notes from the Leyden Museum.—Of volume xiv. numbers 1 and 2 were published in April, and numbers 3 and 4 in July last. Edited by Dr. F. A. Jentink, this volume contains 282 pages and ten plates. The notes on Mammals are; by the editor on *Semnopithecus pyrrhus*, Horsfield; and on *Pithecir melanurus*, S. Muller (Pls. 3 and 4). In volume xii. Dr. Jentink,

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p. 222, gave a note about this latter very rare, nearly forgotten, and often misunderstood little rodent, figured by Alfred Duvaucel in F. Cuvier's great work, the "Histoire Naturelle des Mammifères." Cuvier could give no indication of its size, nor of its native country, guessing that "qu'il est originaire des provinces du Nord de Bengale, si ce n'est des parties occidentales de Sumatra." Dr. S. Müller, in 1834, obtained a specimen in Java, to the northern side of Mount Gede, and named the species. This, and another specimen from Sumatra (also collected by Müller) are both in the Leyden Museum as stuffed specimens. The skulls of these two specimens were detected in the Leyden Museum by Oldfield Thomas, and were included by Jentink in his catalogue of 1887, though with a query. But all doubt on the subject was removed at the date of this paper; and now the animal has been taken alive by Mr. J. D. Pasteur on the northern slope of the Goenong Gedeh, Java, an account of which capture is given in a very graphic translation of a letter to Dr. Jentink. On birds there are papers by J. Büttikofer on the specimens of the genus Tatare in the Museum, on the specific value of Levaillant's "Traquet Commandeur," and on the collections of birds sent by the late A. T. Demery from the Sulymah river, West Africa, pp. 13–30. In this last paper 96 species are recorded, ten of which are new to Liberia; on *Batrachostomus poliolophus*, n. sp. from W. Sumatra, by Ernst Hartert; on a weaver finch from Sumatra; and on a collection of birds from the islands of Flores, Sumba, and Rotti, by J. Büttikofer; and on the birds of Sumba, by A. B. Meyer. About fish there is a note by Dr. Th. W. van Lidth de Jeude on *Orthragoriscus nasus*, Ranzani, which had been washed ashore in November, 1891, at Callantsoog. A figure from a photograph is given.—M. Schepman describes a number of land and fresh water mollusca from Soemba, Timor, and other East Indian islands; several new species are diagnosed.—Dr. J. G. de Man continues his Carcinological studies in the Leyden Museum, and in No. 6 describes several new species which are figured. A very important contribution to our knowledge of the echinoderms is made by Dr. Clemens Hartlaub's paper on the species and structure of the hard parts in Culcita; nine species are carefully described, their geographical distribution is given, *Culcita grex*, M.T., is figured from a photograph, and a fairly complete bibliography is appended. The rest of the papers are descriptions of new forms of insects.

No. 1 of vol. xv., dated as January, 1893, but published October 30 last, contains a review of the genus Rhipidura, with an enumeration of the specimens in the Leyden Museum. A key to the 75 species now known is given—five are described for the first time. M. E. Buchner has a note on the occurrence of *Mellivora indica*, Kerr, in the Trans-Caspian district; on two supposed new species of Pentadactylus, by M. Schepman. There are also several papers on new forms of insects.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 26.—"On the Three-Bar Motion of Watt." By William Brennand. Communicated by C. B. Clarke, F.R.S.

"Further Researches in Connection with the Metallurgy of Bismuth." By Edward Matthey, F.S.A., F.C.S., Assoc. Roy. Sch. Mines. Communicated by Sir G. G. Stokes, Bart., F.R.S.

Paper IV.—"Bismuth, its Separation from Arsenic."—In melting large quantities of bismuth containing arsenic it was found that the surface of the metal being exposed to the air arsenical fumes appeared, and that as the temperature of the metal was raised the arsenic came off in dense white fumes (As_2O_3). An alloy of bismuth containing 0·65 per cent. of arsenic was carefully operated upon and freed from the whole of its arsenical contents, the temperatures being noted at which the separation takes place. When raised to a temperature of 513°C. and maintained at this for a short period, the bismuth was found to be absolutely free from arsenic.

Paper V. "Bismuth, its Separation from Antimony."—Whilst engaged in fusing some 400 or 500 kilogrammes of bismuth containing antimony it was noticed that a peculiar oily film formed on the surface of the alloy, which on being removed and tested was found to contain a considerable percentage of antimony. By continuing the operation and removing the film from time to time as it formed, the melted metal became bright, and was then found to be perfectly free from antimony. A quantity of about 350 kilogrammes of bismuth containing 0·80 per cent. of antimony was melted and the temperature observed at which the antimony separated as described. By maintaining a constant temperature of 458° C. the whole of the antimony separated, leaving the bismuth free from any trace of this metal. The temperatures were determined by the pyrometer of M. H. le Chatelier.

Physical Society, January 13.—Prof. G. F. Fitzgerald, F.R.S., President, in the chair.—Mr. F. W. Sanderson read a paper on science teaching. In this communication the author considers the methods of teaching physical science, and remarks that other sciences may best be treated in some different manner. The method recommended is one found suitable in public schools where boys may remain till about the age of nineteen. In elementary and secondary schools modification would be necessary with a view to making it more immediately useful, whilst in university and technical colleges other methods might be preferable. The object of his public school method was to make physical science a definite means of education, rather than to produce skilled physicists. Certain mathematical subjects, such as arithmetic, geometry, and algebra, should be taught before physics is begun, and taught in such a way as to aid subsequent physical work. In teaching arithmetic it is deemed desirable to distinguish between the science and the art of it, and to have separate hours for instruction in each. The subjects included in each part are described in some detail in the paper. No existing arithmetic satisfies the author's requirements. Geometry is considered of the first importance; practical geometry and the use of instruments forming the best introduction to the subject. It is recommended that the elementary part be taught by the mathematical master with a view to formal geometry, *e.g.* Euclid. As most practical geometries consist of isolated constructions they are useless for teaching the subject in a scientific manner. A number of problems suitable for a graduated introductory course are given. After elementary geometry, mensuration may be taken up with advantage, the facts being verified by drawing to scale, measuring, or by weighing, but no rules being given. Trigonometry of one angle may then be commenced. Here also free use should be made of the drawing board, each pupil finding the sines, cosines, and tangents of angles by drawing and measurement, and making tables. Quite independent of the mathematical class the author has been in the habit of carrying boys on the engineering side through a course of graphical analytical geometry, in which they draw straight lines and the quadratic curves, &c., from their equations, solve simultaneous linear equations, quadratics, cubics, &c. Other geometrical constructions follow. The subject as to what branches of science should be taught in the different departments of a school is then considered, and schemes are given for the classical, modern and commercial, science, and engineering sides. Some general principles which have been kept in view in arranging the physical teaching are next described. In the first place the fundamental experiments and observations on which each scientific law is based are explained to the pupils, and when possible the experiments are performed by the boys in the laboratory. Secondly, from the experiments the laws are stated as precisely as possible, the form of statement depending on the knowledge possessed by the class. The problem of expressing a law mathematically from its most fundamental statement is then fully considered. Thirdly, mathematical deductions from the laws are followed out, and the pupils perform experiments to verify the results, and thus confirm the laws. Fourthly, a course of exact physical measurements is given, which includes mensuration, hydrostatics, mechanics, sound, heat, electricity, and light. A first and second year's course is arranged in each subject, and in both years all the boys work the same experiment at the same time. This necessitates multiplication of apparatus, but being of a simple character in the lower forms where the pupils are numerous it is not prohibitive. It is also stated that boys get better results with comparatively rough apparatus, if large, than with delicate and expensive instruments. About half the time devoted to physics is spent in the laboratory. Mathematics is introduced, as far as can be done without straining the pupils too much, and with young classes appeal is made to experiment where the strictly logical argument would be difficult to follow. Instead of teaching the applications of science as done in some technical schools, the author's method is to teach pure science, and let the applications come in as

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